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Measurements of Skin Friction in Channel Flow

The purpose of these experiments have been to measure the effect of passive means for affecting the skin friction in channel flow. Early measurements indicated that a semi-random distribution of chevrons with a thickness of 5 to 6 wall units could reduce the overall friction in the channel by as much as 12 %, whereas the same type of chevrons uniformly spaced increased the channel friction by 20%. The measurements where these results were obtained were made in a portion of the channel that had not yet reached fully developed channel flow properties.

About 9 months ago the channel length was extended to the maximum length allowed by space restrictions in the building housing the experiment. This gave a total length of the channel of 432 half heights which is sufficient for a 4 m section where all aspects of the flow exhibit fully developed behavior. Measurements in this portion of the channel indicate that there is no measurable friction reduction for the case when chevrons are distributed in a semi-random manner. But there is also no drag increase in spite of the rather large roughness profile presented by the chevrons. Hence, it is clear that this particular distribution of chevrons have a strong influence on the drag producing process in the viscous sublayer region of the channel flow. This clearly calls for further experimentation with variations in the detailed geometry of the chevrons to map out this effect in a rational way with the objective of finding an optimal configuration.

We are now preparing the channel for experiments with uniformly distributed chevrons that previous measurements have shown to produce a substantial drag increase. We anticipate that this will persist in the fully developed flow case. Because an increase in drag implies an enhanced capability for heat transfer, this behavior also has important technical significance, suggesting the need for further investigations.

Our experiments have in the past from time to time been plagued by small variations in the line voltage which resulted in significant fluctuations in the mean flow rate provided by the fan. By replacing the previous AC electric drive motor with a DC motor, this problem has essentially been eliminated.

We have also modified the inlet section of the channel, the connection between the fan and the channel. Instead of screens in the diffuser section we have put in guide vanes that substantially have improved its performance, increasing the maximum flow rate by 20%. A honeycomb in the initial section of the channel eliminates large scale fluctuations and a movable cylinder preceding the honeycomb is used to modify the initial mean velocity profile. This change was made with the expectation that a mean velocity profile here would decrease the distance required to obtain fully developed flow. However, this was not realized.

The results of recent measurements will be detailed in a forthcoming publication.